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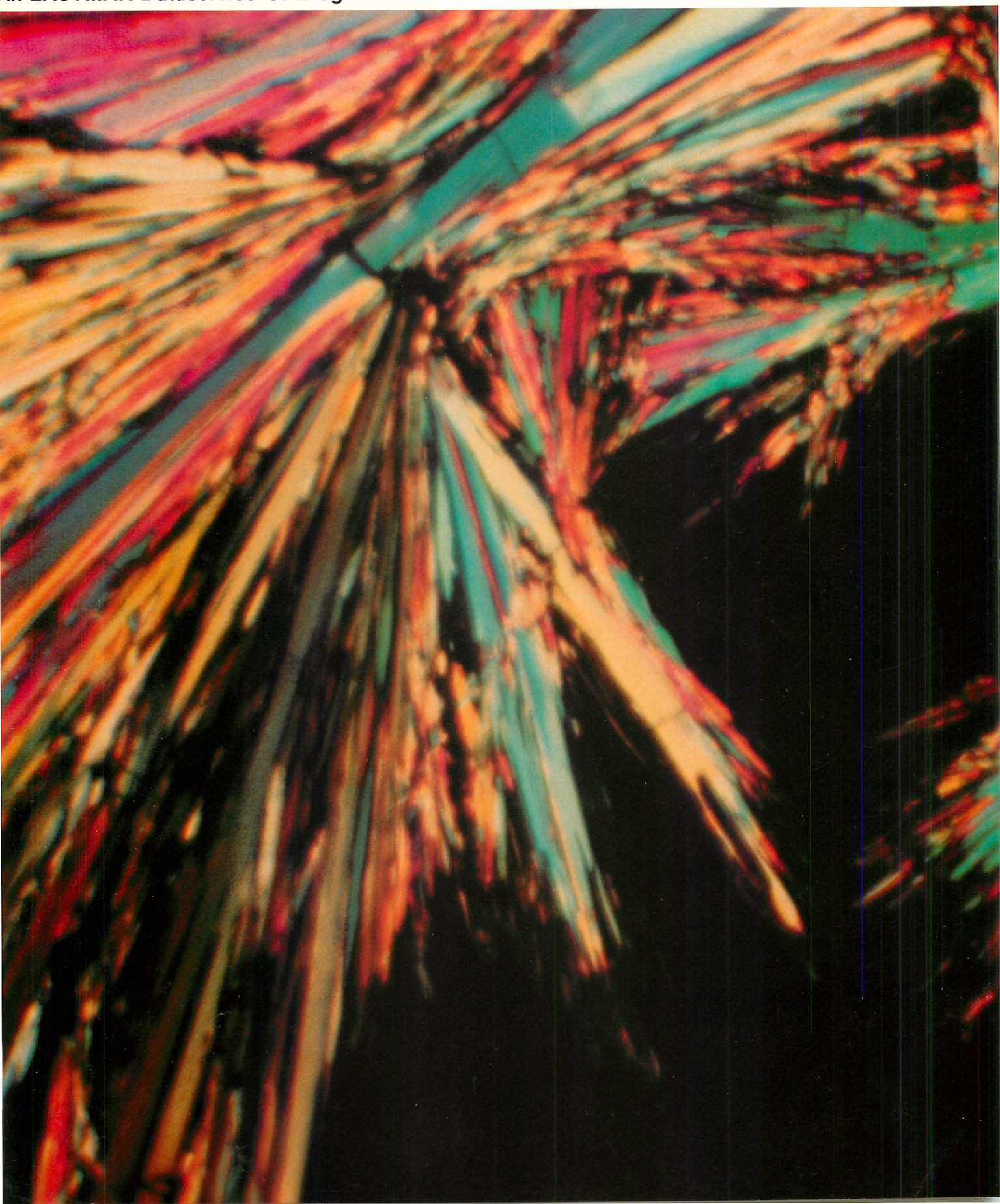

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About the cover:
This photomicrograph of Benzoin, CAT. No. 302, taken at an original magnification of X22, was recorded with tungsten light and crossed polars.

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EASTMAN Products for Electron Microscopy is another in a series of EASTMAN *Dataservice* Catalogs available from Eastman Organic Chemicals. Because electron microscopy is a dynamic science in which new and better techniques are emerging almost daily, the microscopist must rely heavily upon the literature to be kept up-to-date; for this reason, *EASTMAN Products for Electron Microscopy* contains nearly 300 current and easily accessible references that reflect today's state-of-the-art of specimen preparation.

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EASTMAN Products for Electron Microscopy

Contents

page

2 Buffers
2 Fixatives
3 Dehydrating Agents
3 Embedding Media and Reagents for Embedding Media
3 Catalysts and Activators
4 Stains (Contrast Media)
4 Miscellaneous Reagents
5 Some Buffers Commonly Used in Electron Microscopy
6 Bibliography on the Use of Some Fixatives Commonly Used in Electron Microscopy
9 Stain Specificity
10 Bibliography on the Use of Some Stains Commonly Used in Electron Microscopy
18 References
18 Books of Interest
18 Periodicals of Interest
19 Other Kodak Publications for Electron Microscopy
20 Atomic Weights of the Elements

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BUFFERS

CAT. No.	Chemical
285	Ammonium Acetate, Reagent ACS
10457	2-[Bis(2-hydroxyethyl)imino]-2-(hydroxymethyl)-1,3-propanediol
15404	Cacodylic Acid Sodium Salt
7427	3,3-Dimethylglutaric Acid
5416	(Ethylenedinitrilo)tetraacetic Acid
P6274	4-Ethyl Morpholine (Pract.)

CAT. No.	Chemical
13061	Hydrochloric Acid, Reagent ACS
10455	2-(2-Hydroxyethylamino)-2-(hydroxymethyl)-1,3-propanediol
690	Maleic Acid
T227	Sodium Acetate (Techn.)
16668	Sodium Hydroxide (Pellets), Reagent ACS
X4815	2,4,6-Trimethylpyridine (*s*-Collidine)
4833	Tris(hydroxymethyl)aminomethane

GOOD'S BUFFERS

The following hydrogen ion buffers were reported by N. E. Good, *et al,* in an article appearing in *Biochemistry,* 5(2), 467-477 (1966), to be particularly compatible with biological materials. As such, they are appearing with increasing frequency in electron microscopy literature.

CAT. No.		Chemical	pKa at 20°C (The pH of the Midpoint of the Buffering Range)
15000	MES	2-(4-Morpholino)ethanesulfonic Acid	6.15
10354	ADA	*N*-[2-(Acetamido)imino]diacetic Acid	6.6
10356	PIPES	1,4-Piperazinediethanesulfonic Acid	6.8
14998	ACES	*N*-(2-Acetamido)-2-aminoethanesulfonic Acid	6.9
14999	BES	*N,N*-Bis(2-hydroxyethyl)-2-aminoethanesulfonic Acid	7.15
15232	MOPS	3-(4-Morpholino)propanesulfonic Acid	7.2
10517	TES	*N*-[2-Hydroxy-1,1-bis(hydroxymethyl)ethyl]taurine	7.5
10516	HEPES	4-(2-Hydroxyethyl)-1-piperazineethanesulfonic Acid	7.55
15231	EPPS	4-(2-Hydroxyethyl)-1-piperazinepropanesulfonic Acid	8.00
14995	Tricine	*N*-[Tris(hydroxymethyl)methyl]glycine	8.15
7215	Bicine	*N,N*-Bis(2-hydroxyethyl)glycine	8.35
15002	CAPS	3-(Cyclohexylamino)propanesulfonic Acid	10.4

FIXATIVES

CAT. No.	Chemical
468	Acetaldehyde
297	Acetone
13006	Acetone, Reagent ACS
2037	Acrolein
1878	Crotonaldehyde
11445	Dimethyl Suberimidate Dihydrochloride
P450	Formaldehyde (Pract.)
14707	Glutaraldehyde (8% in water)
P8648	Glutaraldehyde (25% in water) (Pract.)
8648	Glutaraldehyde (50% in water)

CAT. No.	Chemical
T4435	Glyoxal (40% in water) (Techn.)
356	Hydroquinone
2119	Osmium Tetroxide (Osmic Acid)
421	Paraformaldehyde
210	Picric Acid, Reagent ACS
863	Potassium Permanganate (Granular), Reagent ACS
P422	Tannic Acid (Pract.)
11214	Uranyl Acetate

DEHYDRATING AGENTS

CAT. No.	Chemical
297	Acetone
13006	Acetone, Reagent ACS
2037	Acrolein
P2270	2-Butoxyethanol (Pract.)
50	Butyl Alcohol
820	*tert*-Butyl Alcohol
1697	2-Ethoxyethanol (CELLOSOLVE†)
133	Ethylene Glycol
303	Isobutyl Alcohol
13029	Isobutyl Alcohol, Reagent ACS
212	Isopropyl Alcohol
13031	Isopropyl Alcohol, Reagent ACS
467	Methanol
13032	Methanol, Reagent ACS
520	Methyl Acetate
1828	2-Methyl-2,4-pentanediol (Hexylene Glycol)
2360	Pentyl Acetate (Amyl Acetate)
2068	Propylene Oxide

EMBEDDING MEDIA AND REAGENTS FOR EMBEDDING MEDIA

CAT. No.	Chemical
P5161	Acrylonitrile (Pract.)
15402	Albumin, Bovine (Fraction V)
5620	Albumin, Egg (Powder)
P2270	2-Butoxyethanol (Pract.)
7387	Carbohydrazide
15403	Collodion, Flexible
1403	Dibutyl Phthalate (DBP)
P9353	2-(Diethylamino)ethyl Methacrylate (Pract.)
P7073	2-Dimethylaminoethyl Methacrylate (Pract.)
318	Dimethyl Phthalate (DMP)
4789	1,2-Epoxyethylbenzene
11459	Ethyl Methacrylate
P450	Formaldehyde (Pract.)
16552	Gelatin (Granular)
14707	Glutaraldehyde (8% in water)
P8648	Glutaraldehyde (25% in water) (Pract.)
8648	Glutaraldehyde (50% in water)
P8366	2-Hydroxyethyl Methacrylate (Pract.)
P8370	Hydroxypropyl Methacrylate (Pract.)
11458	Isobutyl Methacrylate
5703	Methacrylic Acid
8334	Methyl Methacrylate
15412	Polyethylene Glycol 400
15413	Polyethylene Glycol 600
15414	Polyethylene Glycol 1450
15415	Polyethylene Glycol 6000
2068	Propylene Oxide
222	Resorcinol
1465	Styrene
269	Urea, Reagent ACS
5464	2-Vinylpyridine
P10544	4-Vinylpyridine (Pract.)

CATALYSTS AND ACTIVATORS

CAT. No.	Chemical
11151	Ammonium Peroxydisulfate, Reagent ACS
6400	2,2′-Azobis(2-methylpropionitrile)
302	Benzoin
P302	Benzoin (Pract.)
8474	Benzoin Methyl Ether
715	2-Dimethylaminoethanol
P685	*m*-Dimethylaminophenol (Pract.)
97	*N,N*-Dimethylaniline
1793	*N,N*-Dimethylbenzylamine
2471	*N,N*-Dimethyl-*m*-toluidine
646	*N,N*-Dimethyl-*p*-toluidine
P3788	3-Hydroxy-2-butanone (Pract.)
10038	*N,N*,2,6-Tetramethylaniline
9859	*N,N*,3,5-Tetramethylaniline

†Trademark of Carbide and Carbon Chemicals Corp.

STAINS (Contrast Media)

CAT. No.	Chemical
1757	Acridine Orange
14091	ALCIAN† Blue
13182	Ammonium Molybdate, Reagent ACS
C1762	Basic Fuchsin (Cert.) (Rosaniline Chloride)
2409	Chloroplatinic Acid, Reagent ACS
15781	Gold Chloride, Reagent ACS
C309	Hematoxylin (Cert.)
815	Iodine, Reagent ACS
7596	Lanthanum Nitrate
11933	Lanthanum Oxide
1975	Lead Acetate, Reagent ACS
11534	Lead Citrate
C573	Methylene Blue (Cert.)
C1294	Orcein (Cert.)
2119	Osmium Tetroxide (Osmic Acid)
4267	Phenylmercuric Acetate
3240	Phenylmercuric Nitrate
1460	Phosphotungstic Acid (PTA)
863	Potassium Permanganate (Granular), Reagent ACS
X491	Silver Nitrate
1973	Sodium Tungstate, Reagent ACS
P422	Tannic Acid (Pract.)
2140	Tetraiodophthalic Anhydride
11573	Thallic Nitrate
10627	Thallous Ethoxide (Thallium Ethylate)
C1755	Thionin (Cert.)
C1756	Toluidine Blue O (Cert.)
1972	Tungstic Acid
11214	Uranyl Acetate
10869	Uranyl Formate
10391	Vanadyl Sulfate

MISCELLANEOUS REAGENTS

P5974 *p*-(Acetoxymercuri)aniline (Pract.)

Post coupler for glucuronidase and acid phosphatase. *J. Histochem. Cytochem.,* 17, 1 (1969).

15402 Albumin, Bovine (Fraction V)

Wetting agent.

7387 Carbohydrazide

Osmium-bridging agent.

15717 Digitonin

Additive for aldehyde fixatives to help retain free cholesterol. *J. Cell Biol.,* 40, 802 (1969).

13027 Glycerol, Reagent ACS

Cryoprotectant.

145 Hexamethylenetetramine (Methenamine)

Used in silver methenamine staining method. *See Stains.*

902 Hydrazine

For removal of fibrous and amorphous components of bone tissue. *Proc. Workshop on Biol. Specimen Prep. Techn. for SEM,* IIT Res. Group, Chicago, 1972, p 335.

13034 Methyl Sulfoxide, Reagent ACS (DMSO)

Additive for aldehyde fixatives to accelerate penetration. *Stain Tech.,* 45, 143 (1970).

Cryoprotectant; denaturing agent.

10606 Periodic Acid

Oxidizing agent used with OsO_4 stain. *See Stains.*

P394 *p*-Phenylenediamine (Pract.)

For enhancing osmium staining. *Stain Tech.,* 47(5), 239 (1972).

11308 Poly(ethyleneimine)

Tracer for studying anionic sites and transport pathways. *J. Histochem. Cytochem.,* 25(5), 384 (1977).

11155 Sucrose

Fixative additive for increasing tonicity.

7372 Thiocarbohydrazide

Osmium-bridging reagent (OTO).

1275 Thiosemicarbazide

Osmium-bridging reagent (OTO).

P6590 Tolylene-2,4-diisocyanate (Pract.)

For cross-linking of proteins; ferritin coupler. *Biochem. Biophys. Acta,* 207, 115 (1970).

13075 TRITON* X-100

Demembranating agent. *J. Ultrastruct. Res.,* 61, 21 (1977). *Trademark of Rohm & Haas.

P521 Zinc Dust (Pract.)

Used with osmium tetroxide and iodide (ZIO). *See Stains.*

†Trademark of Imperial Chemical Industries, Ltd.

SOME BUFFERS COMMONLY USED IN ELECTRON MICROSCOPY

Buffer	Preparation	Characteristics	Advantages	Disadvantages	Reference
Phosphate	Add 2.98 g $NaH_2PO_4 \cdot H_2O$ to 30.40 g $Na_2HPO_4 \cdot 7H_2O$ and make up to 1000 mL with distilled water	pH = 7.35 Osmolarity = 298 osmols 0.135 M	Compatible with biological components; nontoxic to cells; recommended for fixation by perfusion; excellent buffer for OsO_4 and aldehydes; stock solutions are stable for many weeks	Formation of precipitates may occur during fixation	Maunsbach, A., *J. Ultrastruct. Res.*, 15, 242 (1966)
Phosphate	Add 3.31 g $NaH_2PO_4 \cdot H_2O$ to 33.77 g $Na_2HPO_4 \cdot 7H_2O$ and make up to 1000 mL with distilled water	pH = 7.40 Osmolarity = 320 osmols 0.150 M	Same as above; useful for fixation by perfusion with glutaraldehyde of rat CNS	Formation of precipitates may occur during fixation	Karlsson, U., and Schultz, R., *J. Ultrastruct. Res.*, 12, 160 (1965)
Phosphate	Add 5.0 g NaCl to 1.80 g $NaH_2PO_4 \cdot H_2O$ and 23.25 g $Na_2HPO_4 \cdot 7H_2O$; make up to 1000 mL with distilled water	pH = 7.40 Osmolarity = 440 osmols 0.1 M	For OsO_4 fixation of very hydrated tissues	Formation of precipitates may occur during fixation	Karlsson, U., and Schultz, R., *J. Ultrastruct. Res.*, 12, 160 (1965)
Cacodylate	Prepare a 0.4 M solution by adding 21.4 g $(CH_3)_2AsO_2Na \cdot 3H_2O$ to distilled water to make 250 mL; the final 0.2 M solution is prepared by adding 50 mL of the 0.4 M solution to 8 mL of 0.2 M HCl and making up to 100 mL with distilled water; pH can be modified with HCl	pH = 7.20 0.2 M	Easy to prepare; does not support growth of microorganisms; prevents precipitation in fixatives containing calcium; stock solutions are stable for many weeks; effective with aldehyde as well as osmium tetroxide fixatives	Unpleasant odor; toxic	Sabatini, D., *et al, J. Cell Biol.*, 17, 19 (1963)
2,4,6-Trimethyl-pyridine (*s*-Collidine)	Add 2.67 mL *s*-collidine to distilled water to make 50 mL; to this solution add 9 mL of 1.0 N HCl and make up to 100 mL with distilled water; pH can be modified with HCl	pH = 7.4 0.2 M	Stock solution is stable indefinitely; increases the ease of sectioning	Unsuitable for buffering primary OsO_4 and paraformaldehyde fixatives; toxic; unpleasant odor	Bennet, H., and Luft, J., *J. Biophys. Biochem Cytol.*, 6, 113 (1959)

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2037 Acrolein

Stability of cells fixed with glutaraldehyde and acrolein. Carstensen, E., *et al, J. Cell Biol.,* 50, 529 (1971).

Preservation of fine structures in yeast by fixation in a dimethyl sulfoxide-acrolein-glutaraldehyde solution. Schwab, D., *et al, Stain Tech.,* 45, 143 (1970).

Advantages of dichromate-acrolein fixation for preservation of ultrastructural detail. Robison, W., and Lipton, B., *J. Cell Biol.,* 43, 117a (1969).

Microtubule loss with acrolein and bicarbonate-containing fixatives. Schultz, R., and Case, N., *J. Cell Biol.,* 38, 633 (1968).

The use of acrolein as a fixative for light and electron microscopy. Luft, J., *Anat. Rec.,* 133, 305 (1959).

P450 Formaldehyde (Pract.)

Buffered picric acid-formaldehyde: a new, rapid fixative for electron microscopy. Zamboni, L., and DeMartino, C., *J. Cell Biol.,* 35, 148A (1967).

A formaldehyde-glutaraldehyde fixative of high osmolality for use in electron microscopy. Karnovsky, M., *J. Cell Biol.,* 27, 137A (1965).

Studies on formalin fixation for electron microscopy and cytochemical staining purposes. Holt, S., and Hicks, R., *J. Biophys. Biochem. Cytol.,* 11, 31 (1961).

Combinations of formaldehyde and permanganate as fixatives for light and electron microscopy. Kaye, G., and Moses, M., *Anat. Rec.,* 136, 222 (1960).

Glutaraldehyde

14707 Glutaraldehyde (8% in water)

P8648 Glutaraldehyde (25% in water) (Pract.)

8648 Glutaraldehyde (50% in water)

Staining of transverse tubular system of skeletal muscle by tannic acid-glutaraldehyde fixation. Bonilla, E., *J. Ultrastruct. Res.,* 58, 162 (1977).

The osmotic effect of glutaraldehyde during fixation. A transmission electron microscopy, scanning electron microscopy, and cytochemical study. Arborgh, B., *J. Ultrastruct. Res.,* 56, 339 (1976).

Preservation of membrane ultrastructure with aldehyde or imidate fixatives. McMillan, P., and Luftig, R., *J. Ultrastruct. Res.,* 52, 243 (1975).

Osmolarity of osmium tetroxide and glutaraldehyde fixatives, Bone, Q., and Ryan, K., *Histochem. J.,* 4, 331 (1972).

Glutaraldehyde—its purity and stability. Gillette, R., and Gull, K., *Histochemie,* 30, 162 (1972).

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Fixation by means of glutaraldehyde-hydrogen peroxide reaction products. Peracchia, C., and Mittler, B., *J. Cell Biol.,* 53, 234 (1972).

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Preservation of fine structures in yeast by fixation in a dimethyl sulfoxide-acrolein-glutaraldehyde solution. Schwab, D., *Stain Tech.,* 45, 143 (1970).

Effects on tissue fine structure of variations in colloid osmotic pressure of glutaraldehyde fixatives. Bohmann, S., and Maunsbach, A., *J. Ultrastruct. Res.,* 30, 195 (1970).

Some observations on tissue fixed by glutaraldehyde-osmium tetroxide-digitonin mixtures. Napolitano, L., *et al., J. Cell Biol.,* 43, 96a (1969).

Simultaneous glutaraldehyde-osmium tetroxide fixation with postosmication. An improved fixation for electron microscopy of plant and animal cells. Franke, W., *et al, Histochemie,* 19, 162 (1969).

Purification of glutaraldehyde and its significance for preservation of acid phosphates activity. Fahimi, H., and Drochmans, P., *J. Histochem. Cytochem.,* 16, 199 (1968).

The role of buffers in lung fixation with glutaraldehyde and osmium tetroxide. Gil, J., and Weibel, E., *J. Ultrastruct. Res.,* 25, 331 (1968).

Ultrastructure of human leucocytes after simultaneous fixation with glutaraldehyde and osmium tetroxide and 'postfixation' in uranyl acetate. Hirsch, J., and Fedorko, M., *J. Cell Biol.,* 38, 615 (1968).

The influence of different fixatives and fixation methods on the ultrastructure of rat kidney proximal tubule cells. I. Effects of varying osmolality, ionic strength, buffer system and fixative concentration of glutaraldehyde solutions. Maunsbach, A., *J. Ultrastruct. Res.,* 15, 283 (1966).

New ultrastructural characteristics of cells fixed in a glutaraldehyde-osmium mixture. Trump, B., and Bulger, R., *Lab. Invest.,* 15, 368 (1966).

Glutaraldehyde fixation of Gram-negative bacteria. Glauert, A., and Thornley, M., *J. R. Microsc. Soc.,* 85, 449 (1966).

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Differences in membrane configuration between osmium tetroxide-fixed and glutaraldehyde-fixed ciliary epithelium. Tormey, J., *J. Cell Biol.,* 23, 658 (1964).

2119 Osmium Tetroxide (Osmic Acid)

Ultrastructure of lungs fixed in inflation using a new osmium-fluorocarbon technique. Thurston, R., *J. Ultrastruct. Res.,* 56, 39 (1976).

Osmolarity of osmium tetroxide and glutaraldehyde fixatives. Bone, Q., and Ryan, K., *Histochem. J.,* 4, 331 (1972).

Use of small angle x-ray diffraction to investigate disordering of membranes during preparation for electron microscopy. I. Osmium tetroxide and potassium permanganate. Moretz, *et al, Biochim. Biophys. Acta,* 193, 1 (1969).

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Effects of varying the vehicle for OsO_4 in tissue fixation. Caulfield, J., *J. Biophys. Biochem. Cytol.,* 3, 827 (1957).

421 Paraformaldehyde

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Some remarks on paraformaldehyde fixation. Millonig, G., and Bosco, M., *J. Cell Biol.,* 35, 177A (1967).

863 Potassium Permanganate (Granular), Reagent ACS

Studies on reaction and binding of monoamines after fixation and processing for electron microscopy with special reference to fixation with potassium permanganate. Hökfelt, T., and Jonsson, G., *Histochemie,* 16, 45 (1968).

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Permanganate fixation of plant cells. Mollenhauer, H., *J. Biophys. Biochem. Cytol.,* 6, 431 (1959).

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11214 Uranyl Acetate

Uranyl salts as fixatives for electron microscopy. Study of the membrane ultrastructure and phospholipid loss in bacilli. Silva, M., *et al, Biochim. Biophys. Acta,* 223, 513 (1971).

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STAIN SPECIFICITY

The information contained in this table is condensed from the references appearing in the Stain Bibliography section of this publication, pages 10 to 18. For journal references and further details on a particular stain's use, please consult that section.

Cellular Component Stained	Acridine Orange	ALCIAN† Blue	Hematoxylin	Iodine	Lanthanum Nitrate	Lead Acetate	Lead Citrate	Osmium Tetroxide	OsO_4-Thiosemicarbazide (Thiocarbohydrazide)	OsO_4-Zinc-Iodine (ZIO)	OsO_4-Periodic Acid-Thiosemicarbazide (PATO)	Phosphotungstic Acid (PTA)	Potassium Permanganate	Silver Nitrate	Silver Nitrate-Hexamethylenetetramine	Thallium Ethoxide (Thallium Ethylate)	Toluidine Blue O	Uranyl Acetate	Vanadyl Sulfate
Acid Mucopolysaccharides		X			X			X	X										
Bacterial Membranes								X				X						X	
Basement Membranes														X					
Cartilage														X					
Cartilage Granules		X																	
Cell Walls		X			X			X				X						X	
Cellulose																		X	
Chromatin	X							X				X		X		X		X	
Collagen								X				X							X
Endoplasmic Reticulum								X		X									X
Epithelial Cells							X				X	X					X		
Extracellular Materials		X			X			X											
Glycogen				X				X			X	X		X	X				X
Glycoproteins					X				X			X		X					
Golgi							X	X		X				X					X
Intracellular Membranes								X											
Keratin							X						X	X	X	X			
Leukocytes												X	X						
Lipids					X		X												
Lipofuscin														X					
Lysosomes												X		X	X				
Melanin														X					
Membranes								X	X									X	
Microtubules				X														X	
Mucosubstances		X										X		X					
Multivesicular Bodies								X											
Neurons								X		X		X							
Nucleic Acids	X				X			X						X		X		X	
Nucleoli						X	X					X		X				X	
Nucleoproteins														X				X	
Perinuclear Cisternae								X		X									
Phospholipoproteins																		X	
Platelets							X											X	
Pollen Walls					X														
Polysaccharides															X	X			
Proteins, Myelin Basic			X									X			X			X	
Ribonucleoproteins						X	X							X	X			X	
Ribosomes							X							X				X	X
Sperm																		X	
Starch Granules				X										X					
Synapses										X									
Synaptic Junctions										X		X							
Synthetic Membranes					X			X											
Viral Surfaces												X				X		X	

†Trademark of Imperial Chemical Industries, Ltd.

BIBLIOGRAPHY ON THE USE OF SOME STAINS COMMONLY USED IN ELECTRON MICROSCOPY

1757 Acridine Orange

Ultrastructural probes on DNA templates within human bone marrow and lymph node cells. Frenster, J., *Adv. Cell Mol. Biol.,* 3, 1 (1974).

Used acridine orange to detect changes in DNA template activity within cells.

Ultrastructure and function of heterochromatin and euchromatin. Frenster, J., *Cell Nucl.,* 1, 565 (1974).

Ultrastructural probes of chromatin within living human lymphocytes. Frenster, J., *Nature, New Biol.,* 236, 175 (1972).

Electron microscopic localization of acridine orange binding to DNA within human leukemic bone marrow cells. Frenster, J., *Cancer Res.,* 34, 1128 (1971).

The author detected acridine orange binding sites specific for DNA. Spicules were postfixed with 1% osmium tetroxide prior to embedding and sectioning. Poststaining with uranyl acetate may be necessary.

14091 ALCIAN† Blue

Electron microscopic demonstration of proteoglycans in guinea pig epiphyseal cartilage. Thyberg, J., Lohmander, S., and Friberg, U., *J. Ultrastruct. Res,,* 45, 407 (1973).

ALCIAN† Blue and ruthenium red were used to study cartilage ultrastructure. Extracellularly, both dyes stained matrix granules, but not collagen fibrils. Intracellularly, ruthenium red stained the Golgi vacuole granules; ALCIAN† Blue did not.

Ultrahistochemical demonstration of ALCIAN† Blue stained mucosubstances by the sulfide-silver reaction. Geyer, G., Helmke, U., and Christner, A., *Acta Histochem.,* 40, 80 (1971).

Used ALCIAN† Blue in conjunction with silver nitrate impregnation to demonstrate acid mucosubstances in goblet and Paneth cells.

Preservation of intercellular substances by the cationic dye, ALCIAN† Blue, in preparative procedures for electron microscopy. Behnke, O., and Zelander, T., *J. Ultrastruct. Res.,* 31, 424 (1970).

Demonstrated cell coatings of a number of cell types. The procedure calls for fixing the tissues for 1 to 18 hours in 4% glutaraldehyde containing 1% ALCIAN† Blue and buffered at pH 6.5. Specimens were then postfixed at the same pH with 2% osmium tetroxide for 1 to 4 hours.

Electron microscopic demonstration of acid mucopolysaccharides in the synovial membrane of an adult dog. Ohkura, T., *Proc. 6th Int. Cong. Electron Micros. Japan,* 2, 67 (1966).

Demonstrated acid mucopolysaccharides by intravital perfusion. The diameter of the electron-opaque aggregates in the intercellular matrix ranges from 300-500 Å.

13182 Ammonium Molybdate, Reagent ACS

Configurational changes in isolated rat liver mitochondria as revealed by negative staining. III. Modifications caused by uncoupling agents. Muscatello, U., *et al, J. Ultrastruct. Res.,* 52, 2 (1975).

C309 Hematoxylin (Cert.)

Histochemistry of myelin - XII. Anionic staining of myelin basic proteins for histology, electrophoresis, and electron microscopy. Adams, C., Bayliss, O., Hallpike, J., and Turner, D., *J. Neurochem.,* 18, 389 (1971).

Used phosphotungstic acid-hematoxylin (PTAH); demonstrated the laminated structure of myelin in the central nervous system.

815 Iodine, Reagent ACS

The use of elemental iodine to enhance staining of thin sections to be viewed in the electron microscope. Williams, M., and Adrian, E., *Stain Tech.,* 52(5), 269 (1977).

Used iodine to increase contrast in thin sections of rabbit oviducts (tetrahymena pyriformis) stained with Reynold's lead citrate. Specimens were exposed to iodine vapor for 30 seconds. Cross sections of basal bodies show that microtubular subunits and other ultrastructural details are well preserved with iodine.

Electron microscopic studies of amylose fibrils and star-shaped molecules derived from glycogen in the form of the iodine complex. Bittinger, H., Husemann, E., and Pranemuller, B., *Staerke,* 23, 113 (1971).

Preliminary experiments with iodine in electron opaque stains for ultrathin sections. Flood, P., *Proc. 7th Intern. Cong. Electron Micros.,* 1, 431 (1970).

Stained sections of chlorella pyrenoidosa with iodine followed by lead citrate; iodine blackened starch granules and internal cell walls, but all other cell components appeared as if stained with lead citrate alone. Also examined rabbit liver sections, after iodine staining, noting that only glycogen was blackened.

7596 Lanthanum Nitrate

Gap junctions and rhombic particle arrays in planaria. Quick, D., and Johnson, R., *J. Ultrastruct. Res.,* 60(3), 348 (1977).

Lanthanum 'staining' of the lateral and basal membranes of the mitochondria-rich cell in toad bladder epithelium. Strum, J., *J. Ultrastruct. Res.,* 59(2), 126 (1977).

Lanthanum displaced calcium ion binding sites.

Scanning electron microscopy of T tubules of myocardial cells. Ashraf, M., Livingston, L., and Bloor, C., *Proc. Workshop Adv. Biomed. Appl. of SEM-1976,* IIT Research Inst., Chicago, Ill., p 11.

Prepared lanthanum hydroxide for use as an extracellular tracer by reacting a 4% aqueous solution of lanthanum nitrate with sodium hydroxide.

†Trademark of Imperial Chemical Industries, Ltd.

Neutralized lanthanum solution: A largely noncolloidal ultrastructural tracer. Schatzki, P., and Newsome, A., *Stain Tech.,* 50(3), 171 (1975).

Demonstrated the interspaces between parenchymal cells, the bile canaliculus, and space of Disse of rat liver after injection of neutralized lanthanum nitrate into the common bile duct.

The distribution of lanthanum in tight junctions of the rat kidney. Martinez-Palomo, A., and Erlij, D., *Pfluegers Arch.,* 343, 267 (1973).

Studied the permeability of rat kidney tubules using $LaNO_3$ tracer.

Lanthanum permeability of the tight junction (zonula occudens) in the renal tubules of the rat. Tisher, C., and Yarger, W., *Kidney Int.,* 3, 238 (1973).

Studied the permeability of rat kidney tubules using $LaNO_3$ tracer.

The use of lanthanum in delineating the apoplastic continuum in plants. Thomson, W., Platt, K., and Campbell, N., *Cytobios,* 8, 57 (1973).

Lanthanum nitrate demonstrated the apoplastic cell wall continuum, including the outer leaflet of the plasmalemma.

The demonstration of complex gap junctions between the cells of the enamel organ with lanthanum nitrate. Garant, P., *J. Ultrastruct. Res.,* 40, 333 (1972).

Employed $LaNO_3$ as an intercellular tracer.

Demonstration of the intercellular spaces of the human eccrine sweat gland by lanthanum. I. The secretary coil. Hashimoto, K., *J. Ultrastruct. Res.,* 36, 249 (1971).

Employed $LaNO_3$ as an intercellular tracer.

Migration of lanthanum through the pollen wall. Rowley, J., and Flynn, J., *Cytobiologie,* 3, 1 (1971).

Demonstrated the binding of $LaNO_3$ tracer to lamellae on the exine, nexine, and intine of the pollen wall.

Properties of lipid bilayer membranes separating two aqueous phases: electron microscope studies. Henn, F., Decker, G., Greenwalt, J., and Thompson, T., *J. Mol. Biol.,* 24, 51 (1967).

Employed $LaNO_3$ followed by $KMnO_4$ for visualizing the trilaminar structure of synthetic phosphatidyl ethanolaminecholestrol membranes.

Electron microscopy of DNA molecules 'stained' with heavy metal salts. Stoeckenius, W., *J. Biophys. Biochem. Cytol.,* 11, 297 (1961).

Showed that lanthanum nitrate acts as both a fixative and stain for electron microscopic studies of nucleic acids.

1975 Lead Acetate, Reagent ACS

Staining of thin sections with lead acetate. Kushida, H., *J. Electronmicr.,* 15, 93 (1966).

Showed that staining activity of lead is enhanced when tissue is pretreated with acetone. Grids are stained by immersion in an 'ethanolic' solution of lead acetate. This solution is stable on exposure to air.

Black staining with lead acetate. Kushida, H., *J. Electronmicr.,* 15, 90 (1966).

Showed that tissue blocks stained with lead acetate before embedding will section as well as unstained blocks.

Lead-ammonium acetate: a staining method for electron microscopy free of contamination by carbonate. Bjorkman, N., and Hellstrom, B., *Stain Tech.,* 40, 169 (1965).

Gives a method for staining sections at a neutral pH. This method almost totally eliminates formation of contaminants.

A simplified method of staining thin sections of biological material with lead hydroxide for electron microscopy. Dalton, A., and Zeigel, R., *J. Biophys. Biochem. Cytol.,* 7, 409 (1960).

Used lead acetate in preference to lead hydroxide, minimizing the formation of lead carbonate which tends to cloud the solution.

11534 Lead Citrate

Scanning electron microscopy of neoplastic lesions of the human colon. Siew, S., *Proc. Workshop Adv. Biomed. Appl. of SEM-1976,* IIT Research Inst., Chicago, Ill., p 11.

Used 1% lead citrate with uranyl acetate to demonstrate the characteristic features of human colonic mucosa on a TEM.

Use of the scanning electron microscope to characterize cell types grown in cultures of human epithelial cells. *Proc. Workshop on Adv. Biomed. Appl. of SEM-1976,* IIT Research Inst., Chicago, Ill., p 122.

Surface ultrastructure of the Golgi complex. Sturgess, J., and Muscarello, M., *Proc. Workshop on Adv. Biomed. Appl. of SEM-1976,* ITT Research Inst., Chicago, Ill., p 146.

Lead citrate enhanced contrast.

Phagocytosis of mitochondria by *in vitro* cultivated diploid human glia cells. Collins, V., *et al, Proc. Workshop on Adv. Biomed. Appl. of SEM-1976,* IIT Research Inst., Chicago, Ill., p 188.

Ultrastructural studies on the inner and outer membranes of unsaturated fatty acid auxotroph of *Escerichia coli.* Li, J., and Fox, C., *J. Ultrastruct. Res.,* 52, 120 (1975).

Thin sections were stained for 30 minutes with 2.0% uranyl acetate followed by 20 minutes with lead citrate. The outer membrane had higher reactivity with lead stain than the inner membrane.

Buffered potassium permanganate-uranyl acetate-lead citrate staining sequence for ultrathin sections. Soloff, B., *Stain Tech.,* 48(4), 159 (1973).

Electron density of tissue cut from most epoxy embedments is increased with triple stain. Sections are treated with 0.9% $KMnO_4$ (buffered at pH 6.5), then a saturated solution of uranyl acetate in 50% ethanol, followed by treatment in 0.2% lead citrate.

Fixation of platelets for scanning and transmission electron microscopy. Mattson, J., *et al, Stain Tech.,* 52(3), 151 (1973).

Glutaraldehyde-fixed platelets are double-stained with uranyl acetate for 30 minutes and lead citrate for 2 minutes. Demonstrated morphology and platelet organelles.

A simplified lead citrate stain for use in electron microscopy. Venable, J., and Coggeshall, R., *J. Cell Biol.,* 25, 407 (1965).

Recommended the following procedure for preparing stain: Dissolve 0.01-0.04 g lead citrate and 0.01 mL of 10 N sodium hydroxide in 10 mL distilled water. Tissue should be exposed to the staining solution for about 1 minute.

The use of lead citrate at high pH as an electron opaque stain in electron microscopy. Reynolds, E., *J. Cell Biol.,* 17, 208 (1963).

Recommends that the staining solution be pH 12.0.

C573 Methylene Blue (Cert.)

The fine structure of autonomic nerves after vital staining with methylene blue. Richardson, K., *Anat. Rec.,* 164, 359 (1969).

2119 Osmium Tetroxide (Osmic Acid)

Preparation of fossil specimen for scanning electron microscopy. Pawlicki, R., *Stain Tech.,* 51(3), 147 (1976).

Demonstrated vascular canals, inner wall of vascular canals, and surfaces of isolated osteocytes of dinosaur bone.

Selective glycogen contrast by hexavalent oxide compounds. deBruijn, W., and den Breejen, P., *Histochem. J.,* 6, 61 (1974).

In the presence of K^+, osmium tetroxide stains glycogen. Ribosomes and lipid droplets remain unstained.

A reproducible selective stain for cardiac sarcoplasmic reticulum. Waugh, R., and Sommer, J., *Proc. 32nd Ann. Meet. Electron Micros. Soc. Amer.,* ed. C. Arceneaux, Claitor's Publ. Div., Baton Rouge, La., 1974.

Osmium tetroxide stain contains potassium ferrocyanide. Thin sections are counterstained with uranyl acetate and lead citrate.

Pattern of osmium deposition in the parietal cells of the stomach. Winborn, W., and Seelig, Jr., L., *J. Cell Biol.,* 63, 99 (1974).

Parietal cells exposed to OsO_4 for 60 hours stained the Golgi complex, endoplasmic reticulum, perinuclear cisternae, mitochondrial cristae, multivesicular bodies, and surface coat of intracellular canaliculus microvilli.

Improved contrast in dry ultrathin frozen sections. Werner, G., Morgenstern, E., and Neumann, K., *Histochem. J.,* 6, 111 (1974).

Used OsO_4 in vapor form.

Determination of DNA and polysaccharides using a new Schiff-type reagent. Cogliati, R., and Gautier, A., *C. R. Acad. Sci. Ser. D,* 276(23), 3041 (1973).

OsO_4 treated with ammonia (osmium amine) is a specific stain for DNA. Tissue treated with periodic acid and osmium amine specifically stains polysaccharides. Osmium amine added directly to fixatives revealed extracellular acid mucopolysaccharides.

Immersion fixation of dog retina: factors affecting heterochromatin stainability of photoreceptor nuclei. Ladman, A., *Anat. Rec.,* 175, 365 (1973).

Improved the stainability of osmium tetroxide by addition of divalent cations to the stain solution.

Ultrastructure of the cell wall and cytoplasmic membrane of gram-negative bacteria with different fixation techniques. Silva, M., and Sovsa, J., *J. Bact.,* 113, 953 (1973).

Specimens fixed with OsO_4 in the presence of calcium cations (Ca^{+2}) show enhanced staining.

The use of *p*-phenylenediamine in the block to enhance osmium staining for electron microscopy. Ledingham, J., and Simpson, F., *Stain Tech.,* 47, 239 (1972).

Tissue blocks fixed with osmium tetroxide are post-treated with a 1% ethanolic solution of *p*-phenylenediamine for 15 to 20 minutes. Sections stained by this method do not require poststaining.

Electron opaque fibrils and granules in and between the cell walls of higher plants. Leppard, G., and Covin, J., *J. Cell Biol.,* 53, 695 (1972).

Cells are stained with osmium tetroxide-ruthenium red.

The distribution of osmiophilic lamellae within the alveolar and bronchiolar walls of the mammalian lungs as revealed by osmium-ethanol treatment. Kikkawa, Y., and Kaibara, B., *Amer. J. Anat.,* 134, 203 (1972).

Tissues are fixed in glutaraldehyde followed by osmium tetroxide. After being washed in a suitable buffer, they are postosmicated in a solution containing 2% OsO_4 and 100% ethanol in equal parts.

Lignofibrils on the external cell wall surface of cultured plant cells. Leppard, G., *et al, J. Cell Biol.,* 50, 63 (1971).

Cells are stained with osmium tetroxide-ruthenium red.

Osmiophilia of the saturated phospholipid dipalmitoyl lecithin, and its relationship to the alveolar lining layer of the mammalian lung. Kaibara, M., and Kikkawa, Y., *Amer. J. Anat.,* 132, 61 (1971).

Tissue is treated with osmium-ethanol. Revealed osmiophilic periodic lamellae and surface film of acellular alveolar lining layer.

Osmic staining of amphibian and gastropod photoreceptors. Eakin, R., and Brandenburger, J., *J. Ultrastruct. Res.,* 30, 619 (1970).

Tissue is exposed to osmium tetroxide for 40 to 48 hours, then treated with 0.5% uranyl acetate.

An ultrastructural investigation of calcium-dependent granules in the rat neurophil. Sampson, *et al, Brain Res.,* 22, 157 (1970).

Demonstrates calcium binding sites in neurons.

Electron microscopy staining technique for oriented polymers. Billica, H., Van Veld, R., and Davis, H., *Proc. 7th Int. Cong. Electron Micros.,* 1, 335 (1970).

Osmium tetroxide vapors used to stain and cross-link methyl methacrylate. For study of structure of synthetic textile fibers.

Osmium staining of endoplasmic reticulum and mitochondria in the rat adrenal cortex. Friend, D., and Brassil, G., *J. Cell Biol.,* 46, 252 (1970).

Tissue is exposed to osmium tetroxide for 40 to 48 hours. Lipid droplets, mitochondria matrix inclusions, and outer mitochondrial spaces are not stained.

Cytochemical staining of multivesicular body and Golgi vesicles. Friend, D., *J. Cell Biol.,* 41, 269 (1969).

Negative staining with osmium vapor. Barland, P., and Rojkind, M., *Nature,* 212, 84 (1966).

OsO_4 vapors demonstrate the sites of aldehydic groups in tropocollagen.

Osmium impregnation of the Golgi apparatus. Friend, D., and Murray, M., *Amer. J. Anat.,* 117, 135 (1965).

2119 Osmium Tetroxide - 1275 Thiosemicarbazide

or (7372 Thiocarbohydrazide)

Modified thiocarbohydrazide procedure for scanning electron microscopy: routine use for normal, pathological, or experimental tissues. Malick, L., and Wilson, R., *Stain Tech.,* 50(4), 265 (1975).

OsO_4-TCH technique eliminates the need for an evaporated metal coat.

Ligand-medicated osmium binding: its application in coating biological specimens for scanning electron microscopy. Kelley, R., Dekker, R., and Bluemink, J., *J. Ultrastruct. Res.,* 45, 254 (1973).

Discusses the osmium-bridging character of thiocarbohydrazide; this property can be used to bind additional osmium to a number of soft tissue surfaces for improved contrast.

A new staining method (OTO) for enhancing contrast of lipid-containing membranes and droplets in osmium tetroxide fixed tissue with osmiophilic thiocarbohydrazide (TCH). Seligman, A., *et al, J. Cell Biol.,* 30, 424 (1966).

Histochemical demonstration of some oxidized macromolecules with thiocarbohydrazide (TCH) or thiosemicarbazide (TSC) and osmium tetroxide. Seligman, A., *et al, J. Histochem. Cytochem.,* 13, 629 (1965).

TCH and TSC are used to enhance contrast of glycoproteins.

Osmiophilic reagents: new cytochemical principles for light and electron microscopy. Hanker, J., *et al, Science,* 146, 1039 (1964).

TCH and TSC are used with osmium tetroxide for enhancing contrast of polysaccharides and mucopolysaccharides.

2119 Osmium Tetroxide - P521 Zinc Dust (Pract.) - 815 Iodine, Reagent ACS

(ZIO Stain)

ZIO staining of monoaminergic granulated vesicles. Pellegrino de Iraldi, A., *Brain Res.,* 66, 227 (1974).

Staining of cells of *Zea mays* root apices with the osmium-zinc iodide and osmium impregnation techniques. Dauwalder, M., and Whaley, W., *J. Ultrastruct. Res.,* 45, 279 (1973).

ZIO technique distinctly stains regions of the Golgi apparatus.

Osmium tetroxide-zinc iodide staining of Golgi elements and surface coats of hydras. Elias, P., *et al, J. Ultrastruct. Res.,* 40, 87 (1972).

At pH 7.0, ZIO solution stains Golgi elements, but not cell surface coat.

The relationship between synaptic vesicles, Golgi apparatus, and smooth endoplasmic reticulum: a developmental study using the zinc iodide-osmium technique. Stelzner, D., *Z. Zellforsch.,* 120, 332 (1971).

Osmium-zinc iodide reactivity in human blood and bone marrow cells. Clark, M., and Ackerman, G., *Anat. Rec.,* 170, 81 (1971).

ZIO selectively stains cisternae of rough endoplasmic reticulum, nuclear envelope, mitochondrial matrix, and Golgi complex; does not stain membranes and other organelles.

Zinc iodide-osmium tetroxide impregnation of nerve cell organelles. Madarasz, B., and Hameri, J., *Acta Biol., Acad. Sci. Hung.,* 22, 309 (1971).

ZIO used to study synaptic and cellular organelles in ganglion. Demonstrated fine structure and functional changes.

Structural identification and distribution of synaptic profiles in the *Octopus* brain using zinc iodide-osmium method. Barlow, J., and Martin, R., *Brain Res.,* 25, 241 (1971).

Mapped synaptic vesicles.

The interaction of hippocampal granular cells with OsO_4-zinc iodide stain. Niklowitz, W., *Acta Anat.,* 80, 114 (1971).

Modified the standard ZIO technique by using zinc iodide during glutaraldehyde prefixation; OsO_4 is used alone for postfixation and staining. Gives improved contrast of perkarya and postsynaptic regions; fiber boutons remain unstained.

Osmium zinc iodide reactive sites in the epidermal Langerhans cell. Niebauer, G., *et al, J. Cell Biol.,* 43, 80 (1969).

ZIO selectively stained nuclear envelope of epidermal Langerhans cells, central periodic lamella of Langerhans cell granule, and Golgi region.

Osmium tetroxide-zinc iodide reactive sites in the photoreceptor cells of the retina of the rat. Pellegrino de Iraldi, A., *Z. Zellforsch.,* 101, 203 (1969).

Demonstrated a component present along the photoreceptor cells, including the outer segments of rods and cones.

2119 Osmium Tetroxide -
10606 Periodic Acid -
1275 Thiosemicarbazide
or (7372 Thiocarbohydrazide) (PATO or PATCO Stain)

Ultrahistochemical studies of mucosubstances: electron microscope observation and microbe analysis of the chick embryo cornea. Ohkura, T., *et al, Proc. 31st Ann. EMSA Meeting.* Claitor's Publ. Div., Baton Rouge, La., 1973, p 344.

Studied interfibrillar substances present in mesostroma and corneal epithelium. Specimens were fixed with glutaraldehyde, oxidized with 1% periodic acid, exposed to 1% thiocarbohydrazide, and postfixed with 1% OsO_4 at 60°C for 50 minutes.

Cell division in morphological mutants of *Agmenellum quadruplicatum,* strain BG-1. Ingram, L., and Thurston, E., *Protoplasma,* 71, 55 (1970).

Demonstrated glycogen-like material in blue-green algae.

Osmiophilic reagent: new cytochemical principles for light and electron microscopy. Hanker, J., *et al, Science,* 146, 1039 (1964).

Introduced the PATO (PATCO) method for staining glycogen.

1460 Phosphotungstic Acid (PTA)

Electron histochemistry of mucosubstances in normal human rectal epithelium. Coghill, S., and Hopwood, D., *Histochem. J.,* 9(2), 231 (1977).

Cell surface alterations induced by influenza virus infection. Doane, F., and Anderson, N., *Proc. Workshop on Adv. in Biomed. Appl. of SEM-1976,* IIT Research Inst., Chicago, Ill., p 101.

PTA used as a negative stain for kidney cells and influenza A2 virus.

Validity of phosphotungstic acid staining of polysaccharide (glycogen) at very low pH on thin sections of glycol methacrylate-embedded material. Flechon, J., *J. Microscopie,* 19, 207 (1974).

Axon initial segment and other structures in the neocortex using conventional staining and ethanolic phosphotungstic acid. Sloper, J., and Powell, T., *Brain Res.,* 50(1), 163 (1973).

E-PTA staining revealed axon initial segments, the initial segment undercoating, dense material in somatic subsurface cisternae, cell nucleolis, and central tubules; also specifically stained the degenerating axons and axon terminals.

Preferential staining method for chromatin in electron microscopy. Vazquez Nin, G., Chavez, B., and Thomas Martin, C., *J. Microsc. (Paris),* 16(2), 243 (1973).

PTA (0.5-3.0% in 1 N HCl at pH 2-2.5) preferentially stained DNA in chromatin of ultrathin sections. PTA nonspecifically stained collagen fibrils, external layer of bacterial walls, lysosomes, and blood leukocyte granules.

Phosphotungstic acid at low pH as a section stain for cell surface sialic acid. Dermer, G., *J. Cell Biol.,* 59, 77a (1973).

Specificity of phosphotungstic acid used as a section stain to visualize surface coats of cells. Dermer, G., *J. Ultrastruct. Res.,* 45, 183 (1973).

Surface coats of cells in normal and neoplastic duct epithelium were stained.

Structure and cytochemistry of the acinar cell in the rat maxillary gland. Vidic, B., *Amer. J. Anat.,* 137, 103 (1973).

Used aqueous solution of PTA. Also stained were secretory vesicles containing milk precursor droplets.

An ultrastructural study of the synaptic densities, nematosomes, neurotubules, neurofilaments and of a further three dimensional filamentous network as disclosed by the E-PTA staining procedure. LeBeaux, Y., *Z. Zellforsch.,* 143, 239 (1973).

E-PTA selectively stained basic proteins present in neuronal structures; cellular membraneous components did not cause interference.

Some factors affecting the PTA staining of synaptic junctions. A preliminary comparison of PTA stained junctions in the various regions of the CNS. Jones, D., *Z. Zellforsch.,* 143, 301 (1973).

Synaptic junctions are best demonstrated by fixing in glutaraldehyde followed by exposure to ethanol prior to PTA staining (Glutaraldehyde-E-PTA).

Ultracytochemistry of the periodic acid (PA)-phosphotungstic acid (PTA) reaction. Tsuchiya, A., and Ogawa, K., *J. Electron Micros.,* 22, 290 (1973).

PA-PTA method selectively stains glycoproteins.

The tridimensional ultrastructure of native collagenous fibrils; cytochemical evidence for a carbohydrate matrix. Pease, D., and Bouteille, M., *J. Ultrastruct. Res.,* 35, 339 (1971).

On phosphotungstic acid staining. I and II. Quintarelli, G., Zito, R., and Cifonelli, J., *J. Histochem. Cytochem.,* 19, 641 (1971); 19, 648 (1971).

Discusses the role of pH in determining the selectivity of PTA.

Histochemistry of myelin-XII. Anionic staining of myelin basic proteins for histology, electrophoresis, and electron microscopy. Adams, C., *et al, J. Neurochem.,* 18, 389 (1971).

Used phosphotungstic acid-hematoxylin (PTAH) for demonstrating basic proteins in CNS and peripheral nerve myelin. Showed laminated structure of myelin.

Periodic acid-Schiff-phosphotungstic acid as an electron histochemical method for ultrathin sections. Horobin, R., and Hague, A., *J. Microsc. (Oxford),* 94(Pt. 3), 265 (1971).

Selective stain for PAS-positive structures. Tissues are fixed in OsO_4, dehydrated, and embedded in butyl methacrylate-methyl methacrylate (10:1). After cutting and mounting on formovar-coated gold grids, sections are treated with 1% periodic acid for 10 minutes followed by Schiff reagent for 20 minutes, and stained in 1% aqueous phosphotungstic acid for 1.5 hours.

Phosphotungstic acid as a specific electron stain for complex carbohydrates. Pease, D., *J. Histochem. Cytochem.,* 18, 455 (1970).

Fine structural and cytochemical analysis of the staining of synaptic junctions with phosphotungstic acid. Bloom, F., and Aghajanian, G., *J. Ultrastruct. Res.,* 22, 361 (1968).

Synaptic material was preferentially stained with PTA; synaptic membrane remained unstained.

Phosphotungstic acid as an electron stain. Pease, D., *Proc. 26th Ann. EMSA Meeting-1968,* Claitor's Publ. Div., Baton Rouge, La., p 36.

At pH 1.4-2.0, PTA specifically stains high molecular weight carbohydrates (glycogen, glycoproteins, mucus, etc).

863 Potassium Permanganate (Granular), Reagent ACS

Buffered potassium permanganate-uranyl acetate-lead citrate staining sequence for ultrathin sections. Soloff, B., *Stain Tech.,* 48(4), 159 (1973).

Electron density of tissue cut from most epoxy embedments is increased with triple stain. Sections are treated with 0.9% $KMnO_4$ (buffered at pH 6.5), then a saturated solution of uranyl acetate in 50% ethanol, followed by treatment in 0.2% lead citrate.

Potassium permanganate staining of ultrathin sections for electron microscopy. Sutton, J., *J. Ultrastruct. Res.,* 21, 424 (1968).

Blood leukocyte tissue cultures stained with potassium permanganate show tissue constituents.

Section staining for electron microscopy. Reedy, M., *J. Cell Biol.,* 26, 309 (1965).

Cautions against the use of $KMnO_4$ for poststaining sections embedded in EPON* that contains NADIC METHYL ANHYDRIDE† (NMA) hardener; the hardener will react with the stain.

Electron staining and fine structure of keratins. Rogers, G., and Filshie, B., *Proc. 5th Int. Cong. Electron Micros. Philadelphia O,* vol. 2, Academic Press, N.Y., 1962.

Potassium permanganate intensely stains feather keratins and α-keratins.

X491 Silver Nitrate

Electron microscopy of single cells in the olfactory lobe using Golgi impregnation. Pinching, A., and Brook, R., *J. Neurocytol.,* 2, 157 (1973).

Nucleoli under the electron microscope by silver impregnation. Risueno, C., *et al, Mikroskopie,* 29, 292 (1973).

Demonstrated nucleolus fibrils in plant and animal tissue. Tissue is fixed in 10% formaldehyde-1% hydroquinone (1:1) followed by impregnation with 2% silver nitrate.

A brief note on the chemical nature of the precipitate within nerve fibers after the rapid Golgi reactions: selected area diffraction in high-voltage electron microscopy. Chan-Palay, V., *Z. Anat. Entwickl. Gesch.,* 139, 115 (1973).

Silver staining of ribosomal proteins. Smith, J., and Stuart, R., *J. Cell Sci.,* 9, 253 (1971).

Selectively stained nucleic acid proteins. After fixation in 2% glutaraldehyde (in 0.1 M phosphate buffer containing 0.22 M sucrose), sections are stained by immersion in 5% aqueous silver nitrate.

Electron microscopy of lipofucsin pigment stained by the Schmorl and Fontana technique. Hendy, R., *Histochemie,* 26, 311 (1971).

Uses ammoniacal silver nitrate solution: ammonia is added to 25 mL of 10% aqueous silver nitrate until the solution is clear and contains no precipitate.

Grimelius' silver stain for endocrine cell granules, as shown by electron microscopy. Vasallo, G., Capello, C., and Solcia, E., *Stain Tech.,* 46, 7 (1971).

Golgi potassium dichromate-silver nitrate impregnation. Nature of the precipitate studied by x-ray powder diffraction methods. Fregerslev, S., *et al, Histochemie,* 25, 63 (1971).

An electron microscopic study of silver stained adult human pancreatic islet cells, with reference to new silver nitrate procedure. Grimelius, L., *Acta Soc. Med. Upsal.,*74, 28 (1969).

Specifically stained secretory granules in α-cells, but not β-cells.

*Trademark of Shell Chemical Co.
†Trademark of Allied Chemical Corp.

X491 Silver Nitrate - 145 Hexamethylenetetramine (Methenamine)

(Silver Methenamine Stain)

Electron cytochemical demonstration of sulfhydryl groups in keratohyalin granules and in the peripheral envelope of cornified cells. Jessen, H., *Histochemie,* 33, 15 (1973).

Staining of protein polysaccharide model with silver methenamine. Burr, F., *J. Histochem. Cytochem.,* 21, 386 (1973).

A cytochemical study of the wound-healing protein in *Bryopsis hypnoides.* Burr, F., and Evert, R., *Cytobios.,* 9, 301 (1972).

Modifications of the silver methenamine test for the ultrastructural demonstration of cystine-containing proteins. Burr, F., *J. Histochem. Cytochem.,* 20, 296 (1972).

Sections are treated with sodium bisulfite prior to staining.

Location of polysaccharide on *Chlamydia psittaci* by silver methenamine staining and electron microscopy. Dhir, S., and Boatman, E., *J. Bact.,* 111, 267 (1972).

Sample is pretreated with periodate to expose polysaccharides present.

Application of silver stains to gastric endocrine cells in plastic sections. Weinshellbaum, D., and Pittman, J., *Histochemie,* 29, 134 (1972).

Recommended fixing the tissue in glutaraldehyde-osmium tetroxide.

Demonstration of retinal glycogen with silver methenamine. Sedar, A., and Bresnick, G., *Proc. Electron Microsc. Soc. Amer.,* 29, 564 (1971).

Fine structural cytochemistry of granules in a trial cardiocytes. Berger, J., and Bencosme, S., *J. Mol. Cell Card.,* 3, 111 (1971).

Demonstrated lysosomal granules. Glutaraldehyde-fixed tissue is treated with 1% periodic acid, and stained with silver methenamine (2 mL of 5% silver nitrate in 18 mL of 3% hexamethylenetetramine, plus 2% borax solution).

The nonuniform distribution of protein in plant cell walls. Colvin, J., and Leppard, G., *J. Microscopy,* 11, 285 (1971).

The electron histochemical demonstration of cystine-containing proteins in the guinea pig hair follicle. Swift, J., *Histochemie,* 19, 88 (1969).

Selective staining of secretory granules of adrenal medullary cells by silver methenamine; a light and electron microscopic study. Chang, W., and Bencosme, S., *Can. J. Physiol. Pharmacol.,* 46, 745 (1968).

Identification of argyrophilic cells in pancreatic islets by light and electron microscopy in osmium-fixed, plastic-embedded sections. Lee, D.-H., *Z. Zellforsch.,* 77, 1 (1967).

P422 Tannic Acid (Pract.)

The probable role of phosphatidyl cholines in the tannic acid enhancement of cytomembrane electron contrast. Kalina, M., and Pease, D., *J. Cell Biol.,* 74(3), 742 (1977).

Tannic acid enhances membrane contrast in the presence of osmium tetroxide.

Fixation and staining of F-actin and microfilaments using tannic acid. LaFountain, J., *et al, J. Ultrastruct. Res.,* 58 78 (1977).

Tannic acid-glutaraldehyde is useful where microfilaments may be obscured by other cellular components. Provides active sites for increased deposition of heavy metals.

Tannic acid as a mordant for heavy metal stains. Wagner, R., *Proc. Electron Microsc. Soc. Am.,* 36, 316 (1976).

The effect of tannic acid on electron images of capillary endothelial cell membranes. Wagner, R., *J. Ultrastruct. Res.,* 57, 132 (1976).

Endothelial cells treated with tannic acid-glutaraldehyde increases the thickness and electron density of the outer leaflet of surface membranes.

Desmosome structure revealed by freeze-fracture and tannic acid staining. Shienvold, F., and Kelly, D., *J. Cell Biol.,* 63(2), pt. 2:313a (1974). *Abstr.*

2140 Tetraiodophthalic Anhydride

Organic stains for electron microscopy. Stewart, M., *J. Microscopy,* 97, 381 (1973).

Converted to the acid for a general electron stain.

10627 Thallous Ethoxide (Thallium Ethylate)

Feulgen-derived techniques for electron microscopical cytochemistry of DNA. Moyne, G., *J. Ultrastruct. Res.,* 45, 102 (1973).

Thallium ethylate selectively stains DNA-containing bodies.

Staining nucleic acids and some polysaccharides on ultrathin sections by means of alcoholic thallium. Mentre, P., *J. Microsc. (Paris),* 14(3), 251 (1972).

Thin sections treated with thallous ethoxide reveal nucleic acids and polysaccharides.

C1756 Toluidine Blue O (Cert.)

Scanning electron microscopy of tissues following removal of basement membrane and collagen. Evans, A., *et al,* in *Proc. Workshop Adv. Biomed. Appl. SEM-1976,* IIT Research Inst., Chicago, Ill., p 204.

Toluidine blue O is used for transmission electron microscopical examination of 1 μ sections of epithelial cells.

Observation of the structural components of flagellar axonemes and central pair microtubules from rat sperm. Olson, G., and Linck, R., *J. Ultrastruct. Res.,* 61, 21 (1977).

Axonemal components were visualized by negative staining with 1% aqueous solution of uranyl acetate. Spermatozoa were first demembranated with TRITON† X-100; the flagellum was frayed by mechanical agitation or disintegrated with the addition of 1 mM ATP to the extraction solution (pH 9.0).

†Trademark of Rohm & Haas.

Visualization of ribosome-single-stranded DNA complexes in the electron microscope. Calame, K., and Ihler, G., *Biochemistry,* 16(5), 964 (1977).

Specimens are stained with uranyl acetate and shadowed with Pt-Pd (80:20). Procedure provides for the quantitation of bound ribosomes and should allow for the mapping of ribosome binding sites.

Ultrastructural studies on the inner and outer membranes of unsaturated fatty acid auxotroph of *Escherichia coli.* Li, J., and Fox, C., *J. Ultrastruct. Res.,* 52, 120 (1975).

Thin sections were stained for 30 minutes with 2.0% uranyl acetate followed by 20 minutes with lead citrate. Both the inner (cytoplasmic) and outer (L-membrane) are easily distinguishable.

New electron microscopic studies on the morphology of polyethylenes. Kanig, G., *Strukt. Polym.-Syst., Vortr. Diskuss. Hauptversamml. Kolloid-Ges., 26th,* 176 (1975).

Morphological characteristics of polyethylenes are more easily detected by electron microscopy if the polymer is first treated with chlorosulfonic acid and stained with uranyl acetate.

Poststaining sections for electron microscopy: an alternative procedure. Mollenhauer, H., *Stain Tech.,* 50(4), 292 (1975).

Electron microscopy of cellulose in entire tissue. Cox, G., and Juniper, B., *J. Microscopy,* 97, 343 (1973).

Uranyl acetate followed by lead citrate stained cellulose microfibrils of cell wall.

Buffered potassium permanganate-uranyl acetate-lead citrate staining sequence for ultrathin sections. Soloff, B., *Stain Tech.,* 48(4), 159 (1973).

Electron density of tissue cut from most epoxy embedments is increased with triple stain. Sections are treated with 0.9% $KMnO_4$ (buffered at pH 6.5), then a saturated solution of uranyl acetate in 50% ethanol, followed by treatment in 0.2% lead citrate.

Ultrastructural localization of ribonucleoprotein on mitotic chromosomes of *Cypreus alternifolius.* Papsidero, L., and Braselton, J., *Cytobiologie,* 8, 118 (1973).

Demonstrated ribonucleoprotein-containing regions on mitotic chromosomes. After glutaraldehyde fixation, the tissue is stained in 2% aqueous uranyl acetate followed by 0.2% aqueous lead citrate.

Negative staining. Haschemeyer, R., and Myers, R., in *Principles and Techniques of Electron Microscopy: Biological Applications, Vol. 2,* edited by M. A. Hayat, Van Nostrand Reinhold Co., New York.

Discusses the use of uranyl acetate as a negative stain.

Poststaining sections for electron microscopy. Mollenhauer, H., *Stain Tech.,* 49(5), 305 (1974).

Discusses procedures for poststaining sections with uranyl acetate.

Extent of stain penetration in sections prepared for electron microscopy. Peters, A., Hinds, P., and Vaughn, J., *J. Ultrastruct. Res.,* 36, 37 (1971).

Uranyl acetate stains through the entire thickness of section and cell components, not just the section surface.

Electron staining with uranyl acetate. Possible role of free amino groups. Lombardi, L., *et al, J. Histochem. Cytochem.,* 19, 161 (1971).

The use of deaminating agents (e.g., dinitrofluorobenzene, nitrous acid, chloramine-T) reduces the stainability of uranyl acetate with zymogen granules.

Uranyl acetate as a fixature - from pH 2.0 to 8.0. Mumaw, V., and Munger, B., in *Proc. 29th Ann. EMSA Meeting,* Claitor's Publ. Div., Baton Rouge, La., 1971, p 490.

Uranyl acetate-treated phospholipids are stabilized when treated prior to osmication.

Micropapillae: a surface specialization of human leukocytes. Clawson, C., and Good, R., *J. Cell Biol.,* 48, 207 (1971).

The acidity of the uranyl acetate solution is adjusted to pH 2.0 with HCl.

The effect of potassium permanganate on lecithin and cholesterol monolayer. Shah, D., *Biochim. Biophys. Acta,* 211, 358 (1970).

Demonstrates that uranyl acetate reacts with phosphate groups.

Appearance of nuclear pore complexes after Bernhard's staining procedure. Franke, W., and Falk, H., *Histochemie,* 24, 266 (1970).

Demonstrated the ultrastructure of the nuclear pore complex in both root cells and Hela cells. Tissues were fixed in glutaraldehyde, prestained with uranyl acetate, and treated with EDTA and lead citrate (Bernhard's procedure).

Ultrastructure morphology of telophase prenucleolar bodies with the uranyl-EDTA-lead staining technique. Stockert, J., Colman, O., and Esponda, P., *J. Microscopie,* 9, 823 (1970).

Uranyl acetate as a stain and fixative for heart tissue. Hayat, M., in *Proc. 27th Ann. EMSA Meeting, Claitor's Publ. Div., Baton Rouge, La.,* 1969, p 412.

Shows that high concentrations of uranyl acetate will densely stain both nucleic acids and proteins.

A new staining procedure for electron microscopical cytology. Bernhard, W., *J. Ultrastruct. Res.,* 27, 250 (1969).

Ribonucleoproteins are preferentially, but not specifically, stained when tissues are fixed in glutaraldehyde, prestained with uranyl acetate, followed by treatment with EDTA and lead citrate.

Interaction of uranyl ions with phospholipid and cholesterol monolayer. Shah, D., *J. Colloid and Interf. Sci.,* 29, 210 (1969).

Uranyl ions cross-link phosphate groups in lecithin monolayers, but will not cross-link phosphatidic acid monolayers.

Uranyl acetate, a stain and a fixative. Terzakis, J., *J. Ultrastruct. Res.,* 22, 168, (1968).

Uranyl acetate stains DNA and membranes of malarial parasite. When used before dehydration, uranyl acetate improves tissue preservation.

A protein stain for the electron microscopy of small isometric plant virus particles. Hills, G., and Plaskitt, A., *J. Ultrastruct. Res.,* 25, 323 (1968).

Uranyl acetate preferentially stains protein shell and nucleic acid core. Glutaraldehyde-fixed tissue is stained during dehydration.

10869 Uranyl Formate

Use of uranyl formate as a negative stain. Leberman, R., *J. Mol. Biol.,* 13, 606 (1965).

Useful negative stain for studying the fine structural detail of viruses.

Resolution of the substructure of tobacco mosaic virus in the electron microscope. Finch, J., *J. Mol. Biol.,* 8, 872 (1964).

10391 Vanadyl Sulfate

The use of vanadium as a stain for electron microscopy. Callahan, W., and Horner, J., *J. Cell Biol.,* 20, 350 (1964).

Used vanadyl sulfate as an alternative to lead hydroxide. Vanadium intensely stains cytoplasmic organelles, collagen fibrils, and glycogen granules.

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Wisse, E., *Electron Microscopy and Cytochemistry,* North-Holland Publishers, Flagstaff, Arizona, 1974.

Periodicals of Interest

Electron microscopy is a dynamic field in which much of the current literature can rapidly become outdated. Newer and better techniques and methods are continually replacing those in use today. The following journals and proceedings are available to help keep the electron microscopist abreast of his or her field.

Histochemistry, Deutsche Verlagsanntalt GmbH, 175 Fifth Avenue, New York, New York 10010. Published quarterly.

Histochemistry and Cytochemistry, Pergamon Press, Maxwell House, Fairview Park, Elmsford, New York 10523.

Journal of Cell Biology, American Society for Cell Biology, Rockefeller University Press, 1230 York Avenue, New York, New York 10021. Published monthly.

Journal of Electron Microscopy, Japanese Society of Electron Microscopy - Nihon Denshi Kenbikyo Gakkai, c/o Japan Academic Societies Center, 2-4-16 Yayoi, Bunkyo-Ku, Tokyo 113, Japan.

Journal of Histochemistry and Cytochemistry, Histochemical Society, The Williams and Wilkins Company, 428 East Preston Street, Baltimore, Maryland 21202.

Journal of Microscopy, Royal Microscopical Society, Blackwell Scientific Publications Ltd., Osney Mead, Oxford OX2 OEL, England. Published nine times per year.

Journal of Ultrastructure Research, Academic Press, Inc., 111 Fifth Avenue. New York, New York 10003. Published monthly.

Proceedings of the 30th (1972), 31st (1973) - (to the present year) *Anniversary Meeting of the Electron Microscopy Society of America,* Claitor's Publishing Division, 3165 Acadian Street, Baton Rouge, La. 70821. Published yearly.

Proceedings of the 8th (1975), 9th (1976) - (to the present year) *Symposium on Scanning Electron Microscopy,* SEM Symposium Office, IIT Research Institute, 10 West 35th Street, Chicago, Illinois 60616. Published yearly.

Stain Technology, The Williams and Wilkins Company, 428 East Preston Street, Baltimore, Maryland 21202. Published bimonthly (every two months).

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ATOMIC WEIGHTS OF THE ELEMENTS

Element	Symbol	Atomic number	Atomic weight	Element	Symbol	Atomic number	Atomic weight
Actinium	Ac	89	(227)	Manganese	Mn	25	54.9380
Aluminum	Al	13	26.98154	Mendelevium	Md	101	(258)
Americium	Am	95	(243)	Mercury	Hg	80	200.59
Antimony	Sb	51	121.75	Molybdenum	Mo	42	95.94
Argon	Ar	18	39.948	Neodymium	Nd	60	144.24
Arsenic	As	33	74.9216	Neon	Ne	10	20.179
Astatine	At	85	(210)	Neptunium	Np	93	237.0482*
Barium	Ba	56	137.34	Nickel	Ni	28	58.70
Berkelium	Bk	97	(247)	Niobium	Nb	41	92.9064
Beryllium	Be	4	9.01218	Nitrogen	N	7	14.0067
Bismuth	Bi	83	208.9804	Nobelium	No	102	(255)
Boron	B	5	10.81	Osmium	Os	76	190.2
Bromine	Br	35	79.904	Oxygen	O	8	15.9994
Cadmium	Cd	48	112.40	Palladium	Pd	46	106.4
Calcium	Ca	20	40.08	Phosphorus	P	15	30.97376
Californium	Cf	98	(251)	Platinum	Pt	78	195.09
Carbon	C	6	12.011	Plutonium	Pu	94	(244)
Cerium	Ce	58	140.12	Polonium	Po	84	(209)
Cesium	Cs	55	132.9054	Potassium	K	19	39.098
Chlorine	Cl	17	35.453	Praseodymium	Pr	59	140.9077
Chromium	Cr	24	51.996	Promethium	Pm	61	(145)
Cobalt	Co	27	58.9332	Protactinium	Pa	91	231.0359*
Copper	Cu	29	63.546	Radium	Ra	88	226.0254*
Curium	Cm	96	(247)	Radon	Rn	86	(222)
Dysprosium	Dy	66	162.50	Rhenium	Re	75	186.207
Einsteinium	Es	99	(254)	Rhodium	Rh	45	102.9055
Element 104		104	(261)	Rubidium	Rb	37	85.4678
Element 105		105	(262)	Ruthenium	Ru	44	101.07
Element 106		106	(263)	Samarium	Sm	62	150.4
Erbium	Er	68	167.26	Scandium	Sc	21	44.9559
Europium	Eu	63	151.96	Selenium	Se	34	78.96
Fermium	Fm	100	(257)	Silicon	Si	14	28.086
Fluorine	F	9	18.99840	Silver	Ag	47	107.868
Francium	Fr	87	(223)	Sodium	Na	11	22.98977
Gadolinium	Gd	64	157.25	Strontium	Sr	38	87.62
Gallium	Ga	31	69.72	Sulfur	S	16	32.06
Germanium	Ge	32	72.59	Tantalum	Ta	73	180.9479
Gold	Au	79	196.9665	Technetium	Tc	43	(97)
Hafnium	Hf	72	178.49	Tellurium	Te	52	127.60
Helium	He	2	4.00260	Terbium	Tb	65	158.9254
Holmium	Ho	67	164.9304	Thallium	Tl	81	204.37
Hydrogen	H	1	1.0079	Thorium	Th	90	232.0381*
Indium	In	49	114.82	Thulium	Tm	69	168.9342
Iodine	I	53	126.9045	Tin	Sn	50	118.69
Iridium	Ir	77	192.22	Titanium	Ti	22	47.90
Iron	Fe	26	55.847	Tungsten	W	74	183.85
Krypton	Kr	36	83.80	Uranium	U	92	238.029
Lanthanum	La	57	138.9055	Vanadium	V	23	50.9414
Lawrencium	Lr	103	(260)	Xenon	Xe	54	131.30
Lead	Pb	82	207.2	Ytterbium	Yb	70	173.04
Lithium	Li	3	6.941	Yttrium	Y	39	88.9059
Lutetium	Lu	71	174.97	Zinc	Zn	30	65.38
Magnesium	Mg	12	24.305	Zirconium	Zr	40	91.22

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Values given in parentheses denote the mass number of the longest-lived isotope.

*Atomic weight of the most common long-lived isotope.

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